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Kaiser, Andreas; Kiebach, Wolff-Ragnar; Gurauskis, Jonas; Bjørnetun Haugen, Astri; Ramousse, Severine; Hendriksen, Peter Vang

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Processing and characterization of multilayers for energy device fabrication

A. Kaiser, W.R. Kiebach, J. Gurauskis, A. Bjørnetun Haugen, S. Ramousse, P.V. Hendriksen

Department of Energy Conversion and Storage, Technical University of Denmark, Frederiksborgvej 399, DK-4000 Roskilde, Denmark

*Corresponding author, Tel.: +45 4677 5889; fax: +45 4677 5858. E-mail address: akai@dtu.dk

Abstract

The performance of asymmetric multilayer structures in solid oxide fuel cells (SOFC)/solid oxide electrolysis cells (SOEC), tubular oxygen transport membranes (OTM) and similar high temperature energy devices is often determined by the ceramic fabrication (for given materials and design). A good understanding and control of different processing steps (from powder/materials selection, through shaping and sintering) is of crucial importance to achieve a defect-free multilayer microstructure with the desired properties and performance.

Based on the experiences at DTU Energy with the fabrication of planar SOFC and tubular OTM, we present selected challenges in ceramic processing such asymmetric multilayer structures. By optimizing different steps in the ceramic processing, we improved the mechanical properties and gas permeability of porous supports and the (electrochemical) performance of electrodes/catalytic layers. Optical dilatometry has proven to be a powerful and fast tool to optimize the co-sintering of planar, asymmetric multilayers, consisting of a porous support and a dense membrane layer. The monitoring of dimensional changes and distortions in single and multilayers during de-binding and sintering allows the minimization of sintering stresses, thereby avoiding the formation of defects, such as camber, delamination or crack formation. We briefly highlight recent activities at DTU Energy with advanced processing techniques, such as using electrospinning and 3D printing in fabrication of multilayers.